CONTRIBUTION TO OUR KNOWLEDGE OF AUSTRALIAN *HIRUDINEA*.

Part ii.

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The single specimen of a leech, the description of which forms the subject of this paper, was obtained from a freshwater pool in the vicinity of Oberon, N.S.W. It differs sufficiently from that of any other well known member of the Hirudinea to warrant the institution of a new generic name.

This new genus finds its place in the Family *Herpobdellidæ*, one of the two divisions of the *Arhynchobdellidæ* as classified by R. Blanchard (1894), who gave as the characters of the family:—"Gula maxillis dentatis carens, quandoque tribus pseudognathis chitinosis inermibus ornata, uno medio infero, duobus lateralibus superis. Oculi 8 in duas series a pluribus annulis separatas dispositi, constantesque e duobus paribus anterioribus et duobus paribus posterioribus. Papillæ segmentariæ permultæ, non apparentes. Annuli 5-11 in somito integro, saepius dispares. Pori nephridiales in latere ventris hiantes. Intestinum caecis lateralibus carens. Ova pauca in capsulis ellipticis complanatis pellucidis lapidibusque vel herbis adhaerentibus posita. Habitant aquas dulces."

Oka, in instituting the genus *Orobdella* (1895), found that the above diagnosis, in respect of the number of eyes and the habitat, would have to be altered in order to include *Orobdella* among the *Herpobdellidæ*, to which family it undoubtedly belonged. Oka gave as an amended diagnosis:—"Hirudinea without proboscis, without jaws; eyes in less than 5 pairs, or wholly wanting; rings

without external marking that distinguishes some from the rest; number of rings in a complete somite 5-11."

Had no necessity been found to amend the diagnosis as given by Blanchard, in order to include *Orobdella*, it would now have been necessary to do so in connection only with the eyes.

For this new leech I propose the name

DINETA CYLINDRICA, gen. et sp.nov.

External characters.—Body cylindrical, without any marked change in diameter in any particular part of the body, beyond a slight attenuation towards the anterior extremity. General appearance not unlike that of *Orobdella*. Length, in the contracted condition, about 25 mm.; breadth, in the contracted condition, about 2 mm. Total number of annuli 115.

The surface is exceedingly rugose, each annulus being divided up into a series of squarish tubercular areas by grooves running from the anterior to the posterior margin of each. The appearance of the surface reminds one of the rugose tubercular nature of an Actiniarian such as *Bunodes*. The grooves themselves are of relatively insignificant importance beyond that they express the rugosity. A large number of annuli are also superficially marked by a fine groove which runs round them, dividing the tubercular areas so as to give the appearance of a double row of the same in the annulus. This secondary annulation in some cases becomes so well developed in places that it is difficult to decide whether one is dealing with one or two annuli; and in such cases one has to rely on the pentannulate constitution of the somite as seen in longitudinal section, in making an exact count of the number of annuli. On the whole, however, the annulation is well marked by distinct furrows. The tubercular nature of the surface apparently is merely an expression of the rugosity and has nothing to do with a tactile or sensory function. This rugosity is most marked in the posterior half of the body. Perhaps one might most aptly describe the surface, especially in

the posterior region, as tessellated. The number of annuli in an unabbreviated somite is five (5) as in *Herpobdella* and many other Arhynchobdellids.

There are present no segmental papillæ of any kind, and, as no nephridiopores could be detected in the examination of the entire animal nor any external signs of the metameric constitution, I have had to rely on sections. The separation of the male and female genital apertures by five annuli inclined me, before sectioning, to regard the somite as being pentannulate. The absence of any metameric papillæ, etc., which might serve to distinguish any one annulus from another, is a characteristic of the *Herpobdellidæ* in general.

Although one might be inclined, and reasonably so, to regard the pentannulate nature of the somite as being of generic value, still such is not invariable in some forms. For instance, the three Japanese species of *Orobdella* have, in an unabbreviated somite, four, six, and eight annuli respectively; and yet the internal structures of the three forms show such strong mutual affinities, that this variation is rightly counted as of mere specific importance. We find a similar variation in somitic constitution in species of *Trocheta*; and, in the form under description, secondary annulation reaches in places an important development.

In making out the somites, owing to the absence of papillæ and the difficulty in detecting nephridiopores in an examination of the entire animal, I have had to rely on sections cut longitudinally.

I have adopted the views put forth by Castle, that the ganglia of the ventral nerve-chain lie, not in the first annulus of a somite as stated by Whitman, but in the middle annulus of an unabbreviated segment. In addition to the proof given to his statements by Castle, this position of the ganglion, when we take into consideration the method of somitic extension and its object, if we are to consider the Hirudinea as being derived from a stock allied to the Oligochæta, fits in very well as a natural and not unexpected conclusion, the middle ring representing the stable component of a somite.

The first unabbreviated segment is v. The following table shows the constitution of the abbreviated segments anterior to v.

Somite	i.	Constitution,	Uniannulate.	Annuli	1.
,,	ii.	,,	Triannulate.	,,	2, 3, 4.
,,	iii.	,,	Triannulate.	,,	5, 6, 7.
,,	iv.	,,	Triannulate.	,,	8, 9, 10.
,,	v.	,,	Pentannulate.	,,	11,12,13,14,15.

At the posterior extremity of the body we find somites xxiv.-xxvi. abbreviated.

In *Dina* and *Herpobdella*, the two forms to which this leech bears the closest resemblance, we find that the abbreviated somites include i.-v., and i.-iv., respectively, at the anterior extremity; xxiv.-xxvi, and xxiii.-xxvi., respectively at the posterior extremity.

On close examination of the anterior portion of the body under magnification, it is noticed that the annuli are not exactly alike. The last annulus of each somite is slightly more important in size than the third and fourth, but much more so than the first two annuli. The first two are equal, and the third and fourth are of equal importance.

The diagnosis of *Dina* given by Blanchard is:—"Somitus e 5 annulis constans, tertio majore et transverso diviso. Oculi et clitellum ut in Herpobdella. Somiti i.-v., et xxiv.-xxvi. contracti."

I take it as granted that Blanchard adopted Whitman's method of determining the somites, since Castle's paper has been published much more recently.

If this is the case then the annulus which would be the third according to Whitman would be the last annulus of the somite according to Castle; and it is the corresponding annulus of the somite in the present form which is strongly developed. The anterior four annuli of the somite, however, are of equal importance among themselves in *Dina*, whereas they fall into two consecutive sets in the present form. This differentiation of the annuli composing a somite is not so well marked towards the posterior extremity as towards the anterior end.

The anterior sucker occupies dorsally six annuli, the sixth creeping across to form the posterior lip. The posterior sucker differs very slightly in diameter from the rest of the body, and is set on it obliquely.

There are three pairs of eyes situated on annuli 1, 3, and 6 respectively.

The male genital aperture lies in the midline in the posterior region of the 37th annulus, that is the 32nd postoral ring, or 2nd annulus of somite x., the usual position for it in Arhynchobdellids; its aperture is transversely elongated, and provided with prominent tumid lips. The female genital aperture lies in the midline on the 42nd annulus, that is, the 37th postoral ring, in the 2nd annulus of somite xi.

The anus is situated between the fourth and fifth annuli from the posterior end.

Digestive system.—The mouth-cavity is very wide, measuring about one-third of the body. The pharynx measures about one-third of the body. In transverse section it has the shape of an equilateral triangle with the apex in the dorsal median line. There is a slight groove at each angle, and the sides of the pharynx are convex towards the outer surface of the body. The wall has the same characters as in other Arhynchobdellids, consisting of (a) epithelium; (b) longitudinal muscle-fibres, about five fibres in each row; (c) radial muscle-fibres; (d) circular muscle-fibres, arranged so as to form a circle circumscribing the triangular pharynx, and passing through the apices so that (b) and (c) form plano-convex masses between the epithelium and the circular musculature. The portion of the pharynx between the genital apertures becomes elliptical in shape, the long axis being directed in a dorsoventral line.

In the region of the female genital aperture there appears in the pharynx a peculiar proboscis-like organ. It has a triangular shape, and extends, as such, through about one somite before passing into the œsophagus at the end of the pharynx. The wall of this structure consists of (1) an internal epithelium of columnar cells, very much folded, and sending long projections into the

cavity, whose contour is thereby rendered very irregular; at the base of each of these projecting masses occurs a large capillary; (2) an irregular layer of longitudinal muscle-fibres, much stunted in size; (3) circular muscle-fibres, constituting a good portion of the wall and representing the chief muscle-elements; (4) very irregularly distributed longitudinal muscle-fibres; and (5) an external epithelium, similar in nature to the internal epithelium; immediately beneath this epithelium occur a few large capillaries. This structure, as will be shown later, has no direct relationship to a proboscis, but is, in all probability, connected with the respiratory function. One would at first glance readily imagine that here was shown a rudimentary proboscis which had undergone degeneration, especially with reference to the radial and longitudinal muscle-fibres; and that the genus in this respect represented a form intermediate between the Rhynchobdellid and Arhynchobdellid types.

The œsophagus has an elliptical lumen, the long axis being dorsiventral. The epithelium is very little folded in comparison with that of the proboscis-like structure preceding it. In the relaxed condition of the circular muscle-fibres there is present a dorsal median papilla projecting into the lumen, with a groove on either side of it. At the ventral extremity of the œsophageal wall there is a deep wide groove. Its wall consists of (1) an epithelium of columnar cells; and (2) circular muscle-fibres, well developed, and enclosing occasional longitudinal fibres. The chief points of difference between the wall of the œsophagus and that of the proboscis-like prolongation into the pharyngeal lumen are (1) the less folded epithelium in the œsophageal wall; and (2) the practical absence of capillary vessels beneath its epithelium.

The crop has an epithelium similar to that of the œsophagus, and circular muscle-fibres in its wall. In the relaxed condition it has a dorsal median papilla and an equally well developed ventral median papilla as seen in cross-section, these papillæ representing longitudinal folds. Beneath the epithelium occur numerous capillaries, and in this respect the crop agrees more

with the proboscis-like structure than with the œsophagus. These capillaries are, however, by no means so abundantly or strongly developed as in connection with the former. No diverticula arise from the crop; and in this respect the genus agrees with most other aquatic Herpobdellids, and differs from the terrestrial members, such as *Orobdella* and *Lumbricobdella.*

The intestine has its epithelium folded to such an extent that it projects into the lumen as elongated villose structures. Sinuses are very strongly developed beneath the epithelium, so that in all probability ingestion takes place in this region. The canal opens at the anus between the fourth and fifth annuli from the posterior extremity.

Reproductive organs.—The testes are arranged in the form of capsules along the sides of the ventral sinus, and extending for a short distance up the sides of the digestive canal. There are about seven such capsules. Each testis contains a mass of mature spermatozoa. The male ducts call for no special remarks.

The ovaries are large hollow sacs situated midway between the dorsal and ventral surfaces, each containing a large number of ova which are apparently mature. The ova are large, and form the most prominent cellular elements in this region of the body.

Vascular system.—This system resembles that of *Nephelis* and *Trocheta*, consisting of two lateral vessels, a median ventral sinus, and numerous cœlomic spaces carrying blood.

(a) The lateral vessels are provided with an epithelium consisting of minute cells which take a deep stain with hæmatoxylin. Outside this lining layer is a well developed circular musculature. These channels in all probability are contractile in the living animal, as in the case of *Nephelis* and *Trocheta.*

(b) The ventral sinus, in the single specimen available for examination, was observed to be developed to the extent of having a lumen not many times larger than that of the lateral vessels. In its normal position it lies immediately ventral to the digestive tube; but, in the neighbourhood of the posterior region of the stomach, the digestive tube was found to be pushed towards the dorsal surface, and the ventral sinus separated considerably

from it, and displaced towards the ventral side by a greatly distended blood-laden space

(c) The cœlomic spaces have the same character as those of *Trocheta* and other Herpobdellids. They are arranged in a symmetrical fashion on each side, as mostly hollow sacs of an elliptical oblong or circular shape, as seen in transverse sections. They make their first appearance some little distance behind the female genital aperture. Each sac is lined by an epithelium consisting of cells highly granular in character, the layer having a ragged and slightly disintegrated nature as regards its constituent elements. The granular nature of the cytoplasm of these cells is in all probability due to the presence of pigment granules in each cell, the whole system of these spaces being developed in connection with the botryoidal tissue as in *Trocheta* and *Nephelis*. They extend throughout the postgenital portion of the body as far back as the anal region, and reach their maximum in the middle part of the animal. In the extreme anterior region of their occurrence they appear as three hollow sacs on either side, two immediately dorsal to the ovary and the third directly ventral to that organ and on a horizontal level with the base of the pharynx which, just in this region, passes into the œsophagus. The cavities carry some metameric significance, and communicate with the lateral bloodvessel in each somite. In the first few somites in which they occur, they have the same distribution as described above. Behind this they form a linear series on each side parallel to the sides of the alimentary canal, those of one side communicating with the other side by continuations of the pouches dorsal to the alimentary canal, these connections occurring in each somite. Eventually we find the alimentary canal invested by a series of such spaces arranged so as to give the impression of a complete circle of the same in the region of their greatest development. Although these spaces approach into close association with the ventral sinus, no direct communications between these two forms of chambers were made.

In the region of the intestine enormously distended sinuses are found laden with blood, some reaching such a strong development

as to measure as much as one-third of the body. These spaces, however, show no traces of the botryoidal epithelium which was described above in connection with the botryoidal sinuses.

Nephridia.—No nephridiopores could be seen in an examination of the entire animal, and unfortunately owing to the loss of some sections in the preparation for microscopic examination, I am unable to state exactly how many nephridia are present. No funnels could be detected in a careful examination of the sections, and in this respect we have a point of difference from *Herpobdella*, *Orobdella*, etc., and an approach towards the condition in *Hirudo*, etc. In the anterior region of the body where no cœlomic spaces occur, as described above, the nephridial canals appear to communicate with the lateral bloodvessels. In the region in which the botryoidal sinuses do occur, the nephridial canal-structure is much more massive, and appears as a prominent mass in section, lying on the inner side of the lateral bloodvessel, between that structure and the botryoidal sinuses. The canal-region of the nephridium runs dorsoventrally towards the evacuatory bladder ventrally, and dorsally it is continued as a complex massive structure to pass inwards between the botryoidal sinuses which follow a circular arrangement, and those which are more internally situated and surrounded by the outer ring of sinuses. The canal is continued eventually as a less massive structure, so as to come into close association with the sinus in which lies the testis. The close connection between the canal-cells and the sinuses is, no doubt, connected with the excretory function of the cells of the botryoidal tissue, which are comparable to the excretophore-cells of *Glossiphonia*. In connection with those canals, which I mentioned above as being connected with the lateral bloodvessels, I noticed a small bulging on the inner side of the vessel; and this I regarded as corresponding to a capsule. In this capsule I observed a lumen, but the details of the connection between it and the nephridial canal I cannot tell, although there seems no doubt, from the manner of their association, that such a connection does occur.

The nephridial canal-structure may be described as a sausage-shaped mass bent in the form of the letter U, the convex side

directed towards the dorsal region of the body, and the outer limb longer than the inner and passing down on the inner side of the lateral vessel to join the bladder. The winding of the canal is very similar to that of *Orobdella* and *Herpobdella*. The figure of the nephridium, as reconstructed by Graf from sections of *Herpobdella octoculata* (Linné) 1758, (=*Nephelis vulgaris* Moq.-Tandon, 1827) is, as Oka has mentioned in his description of *Orobdella*, false inasmuch as he has represented the canal as running a simple course from the capsule to the bladder. As in *Orobdella* and *Herpobdella*, so in this new genus, the canal-region of the nephridium consists of a number of large granular cells placed in alignment to form a row. The row of cells is turned on itself several times, so that in transverse section the canal, which pierces the cells in a direction parallel to the length of the row, is seen three or more times. In places, owing to the apparent fusion of the cells and the impossibility of differentiating between the limits of the constituent cells, one might readily imagine that there was a single, simple row of cells, in which was present a much winding canal. That such is not the case is plainly shown in certain regions of the structure by the distinct elementary nature of the constituent cells, each permeated by a single canal when one differentiates between a transverse and a longitudinal section of such a cell.

The bladders attached to the distal extremity of the nephridial canal have the form of a flask, with a very wide venter, continued into a very narrow attenuated neck, which opens on the lateral ventral region of the body through the nephridiopore.

Remarks.—Undoubtedly the Hirudinea in general represent a group of an archaic nature. Their distribution would suggest a great antiquity for the class, and this is supported anatomically by the wide differences, in regard to various organs, in members closely allied from the point of view of classification.

Regarding the relationship of the *Rhynchobdellidæ* and *Arhynchobdellidæ*, one is forced to conclude that these two groups have been evolved from an old stock, probably closely allied to the Oligochæta, sufficiently long enough to allow of the develop-

ment of characters widely divergent in connection with genera in other respects closely allied. This renders it almost impossible, with our present knowledge, to point to any one genus as being more primitive than another.

In the case of the *Glossiphoniidæ*, we have the triannulate somite, which undoubtedly is more primitive than that existing in forms with a greater number of annuli, but from this one cannot judge that the family is any older than another.

The development of a proboscis in the *Rhynchobdellidæ* is to be regarded as a character evolved after the separation of that group from the *Arhynchobdellidæ*. The primitive ancestor of these two groups was not provided with such a proboscis, as can be readily seen from a study of the embryology of the Hirudinea.

In this connection it is rather interesting to note that the Rhynchobdellids are all aquatic forms, and it seems very likely and probable that these forms have, in their proboscidean nature considered in conjunction with their habitat, some explanation of the origin of the group.

In the genus which I have described in this paper, I noted the presence of a peculiar proboscis-like outgrowth from the œsophagus or from the base of the pharynx. One would at first sight readily regard this structure as a rudimentary proboscis, but such is apparently not the case. The proboscis of the Rhynchobdellids is formed by an involution of the anterior extremity of the body, the pharyngeal sac-wall representing the modified epidermis of the involuted portion. A transverse section of the proboscis of these forms is markedly comparable with the anterior extremity of the body of an Arhynchobdellid. An examination of the structure of the proboscis-like organ which I have described in the new form shows that, in this connection, it is not comparable with the proboscis of Rhynchobdellids. I mentioned above that very possibly some relationship existed between the presence of a proboscis in the Rhynchobdellids and their aqueous habitat. Now it seems to me that it is quite probable that the same cause may have stimulated the evolution of the

proboscis in the Rhynchobdellids and the organ under discussion. One marked feature in the structure of this organ is the presence of abundant large capillaries beneath its epithelium, and this would seem to indicate that, in all possibility, it functions as a respiratory organ. It has developed a good circular musculature, and, by the contraction of these muscles, water would be prevented from passing backwards into the digestive tube.

Dineta agrees with other Herpobdellids as regards internal structures, such as the peculiar sinuses formed in connection with the botryoidal tissue and blood-system.

Of the various genera in this family it approaches closest to *Dina*. Indeed, it is possible that it may have to be included in that genus; but, at present, considering the characters given for *Dina* and as I have not any anatomical literature on *Dina*, I feel that I am justified in instituting a new generic name.

BIBLIOGRAPHY.

Blanchard, R., 1894—"Hirudinées de l'Italie continentale et insulaire." *Boll. Mus. Zool. ed Anat. Comp. di Torino.*

Castle, W. E., 1900—"The Metamerism of the Hirudinea." *Proc. Amer. Acad. Arts and Sciences.*

Moore, J. P., 1898—"The Leeches of the U.S. National Museum." *Proc. U.S. Nat. Mus.* xxi.

Apathy, S., 1888—"Süsswasser-Hirudineen. Ein systematischer Essay." *Zool. Jahr. Abth. f. Syst.* Bd. iii.

Grube, E., 1871—"Beschreibungen einiger Egel.-Arten." *Arch. f. Naturgesch.* xxxvii.

Moquin-Tandon, A., 1846—Monographie de la famille des Hirudinées. Paris.

Oka, A., 1895—"Japanese Land Leeches." *Journ. Coll. Sci. Imp. Univ. Tokyo*, viii.

EXPLANATION OF PLATES XXXII.-XXXIII.

Dineta cylindrica, gen. et sp. nov.

Plate xxxii.

Fig. 1.—(See Plate xxxiii.).

Fig. 2.—Ventral view of anterior extremity.

Fig. 3.—Dorsal view of anterior extremity.

Fig. 4.—Lateral view of posterior extremity.

Fig. 5.—Ventral view of posterior extremity.
Fig. 6.—Dorsal view of posterior extremity.

Plate xxxiii.

Fig. 1.—View of the entire animal.
Fig. 7.—Diagrammatic view of anterior extremity, showing arrangement of annuli with reference to anterior sucker.
Fig. 8.—Diagram showing position of genital apertures, with reference to the annuli of somites x. and xi.
Fig. 9.—Section through proboscis-like organ, showing highly vascularised condition.

(Figs. 1-6 drawn from photos.)

ILLUSTRATIONS OF POLYCOTYLEDONY IN THE GENUS *PERSOONIA*, WITH SOME REFERENCE TO *NUYTSIA*.

[N.OO. *Proteaceæ*; *Loranthaceæ*].

By J. J. Fletcher.

(Plates xxxiv.-xxxv.)

About a century ago Sir Joseph Banks gave to the younger Gärtner some botanical specimens, including portion of an Australian plant whose seeds contained embryos with five cotyledons. For this plant Gärtner fil., proposed the name *Pentadactylon angustifolium*, g. et sp. nov. [=*Persoonia linearis* Andr.]; and he included a description of it, with figures, in the Supplement to his father's great work "De Fructibus et Seminibus" published in 1807.* This is the first recorded instance of a polycotylous Protead. But seventy-five years later, Baron von Mueller was able to announce that the peculiarity recognised by C. Gärtner in *Persoonia linearis* was shared, in a varying degree, by the embryos of a substantial majority of the species of *Persoonia* whose fruits were available for examination. This genus, in fact, is without a rival among the Angiosperms for the number of species which habitually produce polycotylous embryos (in the current sense of the term); and in this respect it promises to compare not altogether unfavourably with some of the genera of the Coniferæ

* From the synonymy given on p. 159 of his paper, it appears that Robert Brown had recognised that C. Gärtner's generic name *Pentadactylon* was synonymous with the earlier described *Persoonia* of Smith; but it was left to Mr. Bentham to settle definitely, from the comparison of specimens, that *Pentadactylon angustifolium* C. Gärtn., was synonymous with the earlier name, *Persoonia linearis* of Andrews.